CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Profile for

Candidatus Phytoplasma asteris
Lee, Gundersen-Rindal, Davis, Bottner, Marcone & Seemüller

Aster yellows phytoplasma

Pest Rating: C

Kingdom: Bacteria, Phylum: Tenericutes,
Class: Mollicutes, Order: Acholeplasmatales,
Family: Acholeplasmataceae

Comment Period: 01/16/2025 through 03/02/2025

Initiating Event:

This pathogen has not been through the pest rating process. The risk to California from *Candidatus* Phytoplasma asteris is described herein and a permanent rating is proposed.

History & Status:

Background:

In 1967, Doi et al. observed mollicutes in the phloem of plants exhibiting yellows and witch's broom symptoms. Initially called mycoplasma-like organisms, these single-celled bacteria that lack a cell wall were renamed phytoplasmas. Phytoplasmas are phloem-limited pleomorphic bacteria lacking the cell wall, mainly transmitted through leafhoppers, but also by plant propagation materials. They cause yellowing symptoms by clogging some of the sieve tubes and interfering with the transportation of photosynthate out of the leaves. They can also produce biologically active substances that are toxic, causing the death of the leaves, inflorescences, and vegetative buds of their hosts. Because descriptions of organisms cultured in vitro are required for naming of species in the class Mollicutes, and phytoplasmas are very difficult to isolate and grow in culture, phytoplasma lineages are generally referred to as "Candidatus Phytoplasma species." (Davis and Sinclair, 1998).

Phytoplasmas are plant pathogens that primarily inhabit the phloem sieve-tube, and which are transmitted and naturally disseminated by leafhopper and planthopper insect vectors (Gasparich,

2010). They are obligate in nature with plants and insects, and in most cases require both the plant and insect hosts for their dispersal in nature. *Candidatus* Phytoplasma asteris is a member of the aster yellows phytoplasma group 16SrI. This is the largest and most diverse phytoplasma group (Lee et al., 2004). The name “aster yellows” was first used to describe attacks on China aster, *Callistephus chinensis*. This disease has been widespread throughout the eastern United States for over 100 years (Kunkel, 1926) and in California for almost as long (Kunkel, 1932). Today the term ‘aster yellows phytoplasmas' refers generally to phytoplasma strains that have been separated into subgroups 16SrI-A through -F (Lee et al., 2004).

In Mexico, Brazil, and China, citrus trees infected with *Ca.* Liberibacter asiaticus and showing symptoms of huanglongbing also tested positive for *Ca.* Phytoplasma asteris (Chen et al., 2009; Arratia-Castro et al., 2014). These mixed infections could be contributing to the symptoms and tree damage commonly attributed to *C*a. Liberibacter asiaticus alone. The two pathogens could be acting synergistically as both live and multiply in the phloem of the citrus trees.

Hosts: Candidatus Phytoplasma asteris has a wide host range. Of the nearly 100 recorded hosts, most are herbaceous dicotyledonous plants. Some subgroups are capable of infecting monocotyledonous plants (e.g., maize, onion, gladiolus, oat, wheat, and grass), while others infect woody plants (e.g., grey dogwood, sandalwood, blueberry, mulberry, peach, cherry, olive, grapevine, and paulownia). Many of the plant hosts have been reported on the basis of symptomatology and/or microscopic examinations (McCoy et al., 1989). The identity of the infecting phytoplasmas for many has not been determined with molecular techniques (Marcone et al., 2000).

Symptoms: Symptoms will vary depending on the phytoplasma strain; plants infected with mild strains may show no obvious symptoms. The expression of symptoms also depends on the age of the plant when infected and environmental factors. Symptoms from infection with subgroup 16SrI-A or -B can include virescence (greening of flower petals) and phyllody (development of floral parts into leaf-like structures), flower streaking and malformation, yellowing and upright posture of leaves, elongation and etiolation of internodes, excessive branching of axillary shoots, witches'-broom, and general stunting of plants. Plants may have only one or a few of these symptoms.

Symptoms induced by *Ca.* Phytoplasma asteris subgroup 16SrI-C generally includes virescence and phyllody, without excessive shoot proliferation. Symptoms induced by members of the other 16SrI subgroups inside *Ca.* Phytoplasma asteris include general stunting (little leaves, small flowers, shortening of internodes), leaf curl or rolling, and small and faintly colored flowers (CABI, 2024; Lee et al., 2004).

Transmission: Phytoplasmas may be introduced into new areas by importing vegetative propagating materials that carry the pathogen, often at low titer and asymptomatic. They are spread by phloem -feeding insects. *Macrosteles quadrilineatus*, the aster leafhopper, is a principal vector of *Ca.* Phytoplasma asteris. This insect is C-rated and widespread in California. Several other species of leafhoppers that are polyphagous can transmit the pathogen to a wide range of host plants (Weintraub and Beanland, 2006). Phytoplasmas are not seed-transmitted. The titer of phytoplasma cells in the

phloem of infected plants varies by season and plant species, and it is often very low in woody hosts, presenting a major obstacle to the diagnosis of these phytopathogens.

Damage Potential: Candidatus Phytoplasma asteris causes a variety of problems and symptoms including premature death (Dickinson et al., 2013). Even when infected crops reach harvest, they are often left unmarketable, and the disease has been reported to reduce yields by 10% (Bertaccini and Duduk, 2009). It is one of the most widespread phytoplasmas. Affected vegetable crops important to California include carrots, celery, lettuce, spinach, and tomatoes. A large number of ornamentals can also be damaged (UC IPM https://ipm.ucanr.edu/).

Worldwide Distribution: Americas: *Argentina, Bermuda, Brazil, Canada, Colombia, Costa Rica, Cuba, Guatemala, Mexico, Peru, St. Vincent and the Grenadines, United States of America* (Alaska, Arkansas, California, Connecticut, Florida, Maryland, Michigan, Minnesota, Missouri, New Jersey, New York, Ohio, Oklahoma, South Dakota, Texas, Wisconsin; Asia: *China, India, Indonesia, Iran, Japan, Jordan, Lebanon, Malaysia, Myanmar. Pakistan, South Korea, Sri Lanka, Taiwan, Turkey*; Europe: *Belarus, Belgium, Czechia, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Lithuania, Poland, Portugal, Romania, Russia, Spain, Ukraine, United Kingdom.*

Official Control: *Candidatus* Phytoplasma asteris is on the EPPO's A1 list for Argentina, Bahrain, Jordan, and the Inter-African Phytosanitary Council, a regulated quarantine pest in the United States, and a regulated non-quarantine pest in Switzerland and the United Kingdom (EPPO, 2024). It is on the USDA PCIT's harmful organisms list for China, Ecuador, Guatemala, Honduras, India, Israel, Japan, Jordan, the Republic of Korea, New Zealand, Panama, Paraguay, the Philippines, Sri Lanka, and the United Arab Emirates (USDA PCIT 2024).

California Distribution: Detections have been made in many regions of California including the south coast, central coast, north coast, and Central Valley (French, 1989; CDFA PDR database 2024).

California Interceptions: none

The risk that *Ca.* Phytoplasma asteris would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** This disease is likely to establish wherever its hosts and vectors are present.

Evaluate if the pest would have suitable hosts and climate to establish in California.

Score: **3**

- Low (1) Not likely to establish in California; or likely to establish in very limited areas.
- Medium (2) may be able to be established in a larger but limited part of California.
- **High (3) likely to establish a widespread distribution in California.**

2) **Known Pest Host Range:** The host range across the subgroups is very large including hundreds of plants in multiple families.

   Evaluate the host range of the pest.

   Score: 3
   - Low (1) has a very limited host range.
   - Medium (2) has a moderate host range.
   - High (3) has a wide host range.

3) **Pest Reproductive Potential:** Natural dispersal relies on the insect vectors and the titer of the phytoplasma in the host is variable depending on the season and environmental conditions. Artificial spread is limited to moving infected plants.

   Evaluate the natural and artificial dispersal potential of the pest.

   Score: 2
   - Low (1) does not have high reproductive or dispersal potential.
   - Medium (2) has either high reproductive or dispersal potential.
   - High (3) has both high reproduction and dispersal potential.

4) **Economic Impact:** Crop damage is sporadic but can be significant on crops such as vegetables and ornamentals where there is very low tolerance for damage. Controlling insect vectors can be a significant expense

   Evaluate the economic impact of the pest on California using the criteria below.

   Economic Impact: A, B, E
   A. The pest could lower crop yield.
   B. The pest could lower crop value (including increasing crop production costs).
   C. The pest could trigger the loss of markets (including quarantines).
   D. The pest could negatively change normal cultural practices.
   E. The pest can vector, or is vectored, by another pestiferous organism.
   F. The organism is injurious or poisonous to agriculturally important animals.
   G. The organism can interfere with the delivery or supply of water for agricultural uses.

   Economic Impact Score: **3**
   - Low (1) causes 0 or 1 of these impacts.
   - Medium (2) causes 2 of these impacts.
   - High (3) causes 3 or more of these impacts.

5) **Environmental Impact:** *Candidatus* Phytoplasma asteris has a very large host range which includes both cultivated and non-cultivated plants living in many types of environments.

   Evaluate the environmental impact of the pest on California using the criteria below.

Environmental Impact: A, E

A. The pest could have a significant environmental impact such as lowering biodiversity, disrupting natural communities, or changing ecosystem processes.
B. The pest could directly affect threatened or endangered species.
C. The pest could impact threatened or endangered species by disrupting critical habitats.
D. The pest could trigger additional official or private treatment programs.
E. The pest significantly impacts cultural practices, home/urban gardening, or ornamental plantings.

Environmental Impact Score: 3
- Low (1) causes none of the above to occur.
- Medium (2) causes one of the above to occur.
- High (3) causes two or more of the above to occur.

Consequences of Introduction to California for *Candidatus* Phytoplasma asteris*:* High

Add up the total score and include it here. **14**
-Low = 5-8 points
-Medium = 9-12 points
-High = 13-15 points

6) **Post-Entry Distribution and Survey Information**: Evaluate the known distribution in California. Only official records identified by a taxonomic expert and supported by voucher specimens deposited in natural history collections should be considered. Pest incursions that have been eradicated, are under eradication or have been delimited with no further detections should not be included.

Evaluation is 'High'.

Score: -3
-Not established (0) Pest never detected in California or known only from incursions.
-Low (-1) Pest has a localized distribution in California or is established in one suitable climate/host area (region).
-Medium (-2) Pest is widespread in California but not fully established in the endangered area, or pest established in two contiguous suitable climate/host areas.
-High (-3) Pest has fully established in the endangered area, or pest is reported in more than two contiguous or non-contiguous suitable climate/host areas.

7) **The final score is** the consequences of the introduction score minus the post-entry distribution and survey information score: (Score)

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* ***= 11***

Uncertainty:

Because phytoplasmas are unculturable, Koch's postulates are not used to confirm the pathogenic relationships and resulting disease symptoms between *Ca.* Phytoplasma asteris and its suspected hosts. Advanced diagnostics that use techniques such as nested PCR, DNA sequencing, and *in silico* RFLP analysis from tissues showing symptoms such as virescence and abnormal growth, are more accurate than what was used in the past, often just observational data and a presumption of infection.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for ***Candidatus* Phytoplasma asteris is C.**

References:

Arratia-Castro, A.A., Santos-Cervantes, M.E., Fernández-Herrera, E., Chávez-Medina, J.A., Flores-Zamora, G.L., Camacho-Beltrán, E., Méndez-Lozano, J. and Leyva-López, N.E., 2014. Occurrence of 'Candidatus Phytoplasma asteris' in citrus showing Huanglongbing symptoms in Mexico. Crop Protection, 62, pp.144-151.

Bertaccini, A., and Duduk, B. 2009. Phytoplasma and phytoplasma diseases: A review of recent research. Phytopathol. Mediterr. 48, 355–378.

Chen, J., Pu, X., Deng, X., Liu, S., Li, H. and Civerolo, E., 2009. A phytoplasma related to 'Candidatus Phytoplasma asteris' detected in citrus showing huanglongbing (yellow shoot disease) symptoms in Guangdong, PR China. Phytopathology, 99(3), pp.236-242.

Davis, R.E. and Sinclair, W.A., 1998. Phytoplasma identity and disease etiology. Phytopathology, 88(12), pp.1372-1376

Dickinson, M., Tuffen, M., Hodgetts, J. The Phytoplasmas: An Introduction. In Phytoplasmas: Methods and protocols, 1st ed.; Dickinson, M., Hodgetts, J., Eds.; Humana: New York, NY, USA, 2013; pp. 1–14.

EPPO Database. *Candidatus* Phytoplasma asteris. https://gd.eppo.int/taxon/PHYPAS Accessed 12/30/2024

French, A. M. 1989. California plant disease host index. CA Division of Plant Industry. 2nd Ed. 394 pg

Kunkel, L. O. 1926. Studies on aster yellows. Am J Bot 23, 646–705.

Kunkel, L. O. 1932. Celery yellows of California not identical with the aster yellows of New York. Contrib Boyce Thompson Inst 4, 405–414.

Lee, I.M., Gundersen-Rindal, D.E., Davis, R.E., Bottner, K.D., Marcone, C. and Seemüller, E., 2004. '*Candidatus* Phytoplasma asteris', a novel phytoplasma taxon associated with aster yellows and related diseases. International journal of systematic and evolutionary microbiology, 54(4), pp.1037-1048.

Marcone, C., Lee, I-M., Davis, R.E., Ragozzino, A., Seemüller, E., 2000 . Classification of aster yellows-group phytoplasmas based on combined analyses of ribosomal RNA and tuf gene sequences. International Journal of Systematic and Evolutionary Microbiology, 50: 1703-1713

McCoy, R.E., Caudwell, A., Chang, C.J., Chen, T.A., Chiykowski, L.N., Cousin, M.T., Dale, J.L., de Leeuw, G.T.N., Golino, D.A., Hackett, K.J., Kirkpatrick, B.C., Marwitz, R., Petzold, H., Sinha, R.C., Sugiura, M., Whitcomb, R.F., Yang, I.L., Zhu, B.M., Seemüller, E., 1989. Plant diseases associated with mycoplasma-like organisms. In: Whitcomb RF, Tully, eds. The Mycoplasmas, Vol. V. San Diego, USA: Academic Press, 545-640

USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PExD) Harmful Organisms Database Report. Aster yellows phytoplasma. Accessed 12/30/2024.

Weintraub, P.G., and Beanland, L., 2006. Insect vectors of phytoplasmas. Annual Review of Entomology, 51:91-111. http://www.annualreviews.org

Responsible Party:

Heather J. Martin, Primary Plant Pathologist/Nematologist, CDFA/PHPPS ECOPERS, 1220 N St Rm 221, Sacramento, CA 95814 Phone: (916) 654-1017, permits[@]cdfa.ca.gov.

---

*Comment Period: 01/16/2025 through 03/02/2025

*NOTE:

You must be registered and logged in to post a comment. If you have registered and have not received the registration confirmation, please contact us at permits[@]cdfa.ca.gov.

Comment Format:

- Comments should refer to the appropriate California Pest Rating Proposal Form subsection(s) being commented on, as shown below.

  Example Comment:

  Consequences of Introduction: 1. Climate/Host Interaction: [Your comment that relates to "Climate/Host Interaction" here.]

- Posted comments will not be able to be viewed immediately.

- Comments may not be posted if they:

  Contain inappropriate language which is not germane to the pest rating proposal;

  Contains defamatory, false, inaccurate, abusive, obscene, pornographic, sexually oriented, threatening, racially offensive, discriminatory or illegal material;

  Violates agency regulations prohibiting sexual harassment or other forms of discrimination;

  Violates agency regulations prohibiting workplace violence, including threats.

- Comments may be edited prior to posting to ensure they are entirely germane.
- Posted comments shall be those which have been approved in content and posted to the website to be viewed, not just submitted.

Pest Rating: C